Food and Dreaming

Investigating the importance of time specific food consumption in relation to dreaming frequency

Candidate: 10113

PSY2900 – Bachelor thesis in Psychology

Bachelor´s Thesis

Bachelor of Social Science in Psychology

At

NORWEGIAN UNIVERSITY OF SCIENCE AND TECHNOLOGY

SPRING 2022

Supervisors: Professor Wei Wang and Dr. Torhild Anita Sørengaard

Acknowledgements

First of all, I want to thank one of my supervisors, professor Wei Wang, for allowing me to study dreams by offering to supervise bachelor students and suggesting dreams as the topic of this project. Second, I want to express my appreciation of the astonishing help given by my second supervisor, Dr. Torhild Anita Sørengaard. You offered a lot of help and time to deeply understand my question of interest and have been excellent in giving feedback and motivation. Thank you, Tiffany Lussier and Eline Eyde Lüder-Larsen, for having assisted on the project. You guys have worked hard to help with every little concern. Your help has saved a lot of time and difficulties. I want to thank my roommate and good friend Malin Ugseth for all the discussions of psychological topics which eventually lead into the idea of studying the food-dream association. I also want to thank you for bearing with all my complaints and rants during difficult times with this project. You have certainly been used as an emotional punching bag at times. I want to thank Dr. Xi Chu for suggestion of using statistical methods used in the laboratory in order to investigate my question of interest. Suggestions and discussions saved my question of interest during a difficult time. Thank you, Dr. Jonas Hansen Kymre, for statistical discussions and suggestions of using alternative statistical programs to elevate the level of my thesis. Thank you, Dr. Elena Ian, for sharing your experiences and knowledge about the unconscious mind during lunch breaks which spiked my motivation for further investigation. Thank you, professor Bente G. Berg, for offering me a workplace at your laboratory, so that I could have a fixed place to work with my thesis at the university. Last but not least, I want to give a huge thank you to my partner, which for a long period has motivated me for my work, allowing me to completely relax in between working hours, essential to keep up with the work. Also, for making me realize what power I possess at hand, and when not to concern about irrational thoughts. Your love and support have been extremely important to me, especially, during this period.

Abstract

Former studies have revealed several key factors that may impact an individual´s dreaming, however pre-sleep food consumption has thus far received little attention. The question of whether and how food consumption can affect dreaming is one of the prominent issues in need of systematical investigation. Yet, most studies seem to either have neglected, or been designed to exclude, variables accounting for the specific time of pre-sleep food consumption. In the current study, I aimed at exploring the putative role of time dependent last meal before bedtime in relation to dreaming frequency. In total, 140 people from the general public in Norway were recruited. Among them, 87 managed to follow a daily electronic survey over a four-week period. The survey measured several variables that have been associated with dreaming, in which two of them were specifically designed to quantify the relationship between time of last meal before bedtime and dreaming frequency. Out of the total respondents, 66 participants were valid to be included in the analytic process. The results showed that the average time of last meal before bedtime and total amount of dreams was not linearly correlated. Thus, I conducted an unsupervised two-step cluster analysis using the two variables. The analysis successfully identified three clusters across the subjects. It appeared that the cluster representing participants that ate on average two hours before bedtime showed significantly higher total amount of dreams than the two other clusters with four hours and one and a half hours. Results provided demonstrated that specific time of last meal before bedtime could be an important variable in the food-dream association and should therefore be included in future investigations.

Keywords: food, dreaming, time, correlation, cluster analysis.

Food and Dreaming: Investigating the importance of time specific food consumption in relation to dreaming frequency

Food and dreaming correlations have recently been growing towards an embracing field within the sleep-research. Despite showing significant, non-significant, positive, and negative correlations between dreaming and food, the field seems to either have neglected, or designed to exclude, the time of when the variable accounting for food was consumed. Why most studies have done so, is not understood. E.g., Nielsen and Powell (2015) demonstrated that eating dairy products seemed to be the food most frequently reported to provoke disturbing- and bizarre dreams.

Despite discovering this association, it did not provide any information on when the dairy food was consumed. One would imagine eating dairy food more than four hours before bedtime, would affect differently than consuming dairy food less than one hour before bedtime. Some studies (e.g., Yu & Lam, 2017), have included time of last meal as a variable timed between supper and sleep, but not as being performed during specific hours. Accounting for different daily routines, and cultures, time of supper could also vary between individuals. The current study aimed at discovering meaningful information of time-dependent last meal before bedtime and dreaming frequency, in order to provide reasons not to neglect the specific time of last meal before bedtime as an important variable within the food-dreaming-research field.

Dreams and dream category definitions

Dreams could be described as "experiences that occur during sleep, while being disconnected from the environment" (Siclari et al., 2020, p.1). Literature on the topic of dreaming show that most people have different kinds of dreams during their lifespan (e.g., Wang et al., 2021). One could categorize dreams in different ways, and for most of present literature, the categories *ordinary dream, nightmare, bad dream,* and *sexual dream* occurs the most (e.g., Wang et al., 2021, Chen et al., 2014, Gillespie, 1986, Robert, 2008). Literature on the different terms often tend to not define these terms, and therefore there might be complicated to distinguish between the different terms. Following, and attempt to define the terms based on the present literature will be presented.

Ordinary dream could be understood as a dream reflecting upon everyday life. Situations in which common everyday happenings occur at the level of being interpreted as something which could happen in the awake life reality. Normally, when people describe a

dream which cannot be characterized as nightmare or sexual dream, it is most often an ordinary dream.

Nightmare could be defined as a frightening dream with long duration that makes the sleeper wake up (Hartmann, 1984). Wang et al., (2021) invited 1451 Chinese students to report their dreaming prevalence, in which 923 students reported having nightmares. The annual prevalence in the study was calculated to be 63.61%.

Bad dream has developed from trying to define *nightmares.* Due to inconsistency in the definition of nightmares, there have been a discussion on whether a nightmare needs to wake up the dreamer or not. Thus, the term *bad dream* developed. There have been suggestions of naming a disturbing dream that wakes up the sleeper, *nightmare*, and a disturbing dream that does not wake up the sleeper a *bad dream* (Halliday, 1987, 1991). Thus, a *bad dream* is characterized as a frightening dream with long frequency that does not make the sleeper wake up. Schredl (2020) reported the prevalence of *bad dreams* to be at about 11% of the population.

Sexual dreams might easier be defined. *Sexual dreams* often include sexual behavior, imagery or have a sexual theme (Chen et al., 2015). According to Chen et al., (2015) the prevalence of sexual dreams varies from nation to nation. Calculating a mean of the numbers given from the different nation (in total five nations, Chen et al., 2015) one would get a mean prevalence at about 73.58% of the population.

Influencing the prevalence of different kind of dreams

When it comes to the measured prevalence of the different dreams, it seems to have changed according to different environmental factors (Punämaki, 1998). For instance, Merritt et al., (1994) found that major shifts in emotions is positively correlated with *ordinary dream* frequency. Secrist et al., (2019) emphasized that trauma history and anxiety accounted for 39% of *nightmare* distress variance. Solomonova et al., (2021) discovered that high levels of stress are positively correlated with *bad dream* frequency. For *sexual dreams*, Schredl et al., (2019) revealed a negative association with age. All these results emphasize the importance of understanding influencing variables on dreams.

Food as a variable associated with dreaming

While there have been various variables suggested to be associated with dream prevalence, there are some variables that over the last years have become more researched than in the past. For instance, up until 2017 there were only two studies researching how food intake were associated with the frequency of dreams (Yu & Lam, 2017). Korth, Briggs, Cummings, Rodriguez, and Martin (2007) showed that dreams were positively associated with a preference for certain types of food. The idea that some foods seemed to be positively correlated with dream content were supported by earlier studies (e.g. Kleitman et al., 1937; Frayn, 1991; Baireuther, 1997; Ebben, el al., 2002; Lauemah, 2003). Nielsen and Powell (2015) also showed that participants indicated that eating certain foods affected their dreams. More specific 68 of the participants, which counted for 17.8% of the total participants, reported that either eating particular foods or late-night eating seemed to affect their dreams (Nielsen & Powell, 2015).

Food and sleep quality

Although the two studies from Korth et al., and Nielsen and Powell, revealed associations between food and dreams, other studies have also discovered dietary nutrition to have effect on sleep in general. The average human diet often contains, among other components, carbohydrates, fatty acids, amino acids, and vitamins, which all have been shown to correlate with sleep. Low-carbohydrate intake has been shown to positively correlate with sleep difficulties (Tanaka et al., 2013). Higher daytime saturated fat intake has been demonstrated to be associated with more arousal during the night (St-Onge et al., 2016). Tryptophan, a substrate from serotonin, has been suggested to consistently reduce the time it takes to go from being fully awake to sleeping (George et al., 1989). Vitamins C levels have been demonstrated to be higher in adult long-sleepers (Noorwali et al., 2018).

Considering the human diet to vary individually, systematically mapping correlations between food intake and sleep could be rather difficult. Despite causing trouble for systematic mapping, suggesting nutrition to be a variable correlating with sleep wellness, has also unfolded various confounding variables. Nutrition has been discovered to significantly depend on various factors such as metabiotic functions and digestive system, as well as affecting hormone levels and systemic inflammation (Zhao et al, 2020). All this is based on the nutrition system that fuels the biologic brain.

Brain activity and energy resources

Food being associated with sleep and dreaming would also be supported by the fact that in order for the brain to provide maximum efficiency, it requires energy consumed through for instance different types of food (e.g., Pellerin, 2010). Most of this energy comes from glucose which is found in for example honey, fruit, and cured ham. Glucose is used in the body for production of adenosine triphosphate (ATP), largely used to provide energy to neurons, making up the nervous system. Glucose levels have been shown to positively correlate with appearance of pathological signs. This could eventually lead to various diseases, such as obesity, diabetes, or neuropathy (López-Gambero et al., 2019).

As well as being associated with variations in brain function, food has also been related to central nervous system functionality, which according to Fishbein and Meduski (1987) might include dreaming. An essential point of view is that different foods include different sources which could be the foundation for energy consumption effecting brain activity. For instance, Greenwood and Wincour (1990) reported a negative association between diets high in saturated fat and cholesterol, and impaired learning and memory functions. This could be exemplified through showing the positive correlation between fat and cholesterol high diets, and increased risk of dementia (Kalmijn, 1997), in which dementia is characterized by "impairment in attention, memory, executive and visuo-spatial functions, behavioral symptoms such as affective changes, hallucinations, and apathy are frequent" (Emre et al., 2007, p.2).

The oxygen dependent brain

The human brain could be understood as an oxygen dependent structure, in which different cerebral and cortical areas critically depends on oxygen to function. Modern brain imaging techniques, such as the blood oxygen level dependent functional magnetic resonance imaging (BOLD-fMRI), takes advantage of this in order to measure brain activity and cerebral location of the activity. This is based on blood rich in oxygen entering and getting taken up by a specific brain region of interest. The BOLD-fMRI then measures how much oxygen rich blood that enters the region of interest, and how much less oxygen there is in the blood when it leaves the region (e.g., Logothetis, 2004).

This emphasizes the importance of oxygen in the brain, and research has shown that having a diet which includes high levels of refined carbohydrates and fat, seems to be associated with decreased levels of oxygen in the brain and therefore being associated with an

increased propensity for hypoxia (Miller, 2004). Moreover, studies have shown hypoxia to be positively correlated with breathing temporarily ceases during sleep (Miller, 2004), also known as sleep apnea, which also could affect dreaming.

Limitations despite correlations

In other words, several studies have pointed in the direction of food being correlated with, among other factors, brain activity, sleep, and dreams. Despite correlations to have been discovered, there is little research controlling for the variable of time. Most of presented research have been correlation studies investigating the association between different foods, and either sleep quality or dreaming frequency. Yet, there seems to be a lack of information concerning the time of food consumption, relative to bedtime and dreaming frequency.

Discovering either negative or positive correlations between dreaming frequency and foods, studies seem to have excluded measures for when the participants ate before going to sleep. Not controlling for, or designing to exclude, certain variables could provide results that do not reflect upon the actual relationship between the variables studied (Pourhoseingholi et al., 2012).

Even though some studies have emphasized that eating late at night seems to correlate with dreaming frequency, time as a variable have been poorly defined. Yu and Lam (2017) indicated that people holding the belief that eating a fourth meal would affect their dreaming frequency, indeed scored higher on the Dream Intensity Scale (DIS; Yu, 2012), measuring subjective intensity of dreaming that characterizes a person (Yu & Lam, 2017, p. 25). In this context eating a fourth meal, defined as the Cantonese expression "*siu-yeh*"(消夜), was only described as eating at night between supper and sleep. Thus, eating at night were neither defined nor described as being performed during specific hours.

Time as a defined variable in food-dream associations

When trying to define time of food consumption as a variable, several limitations occur. The most prominent being that most people seem to not be consistent in time of last meal before bedtime. Solving this limitation, could include defining time of last meal before bedtime as being a variable measured on average. Measuring this variable on average allows for further investigations to include the variable more easily.

Question to be researched

Based on the lack of well-defined time frames for eating late at night, the current study aimed at investigating differences in dreaming frequency based on time of last meal before bedtime. Thus, the research question was formulated as follow:

Are there any differences in total amount of dreams based on average time of food consumption before bedtime?

Hypothesis

The presented literature and research question evolved in the following hypothesis:

1. There is a positive association between average time of food consumption before bedtime and the total amount of dreams.
2. There are differences in average time of last meal before bedtime and total amount of dreams in between subjects.

Methods

Sample

A total of 140 participants expressed their interest in participating in the project, in which 87 (62.14%) answered the questionnaires over the sampling period. The age of respondents varied from 20 to 78 years with mean age 29.27 years (*SD* = 12.75), and the sample consisted of 40 men (46%) and 47 women (54%).

Design and procedure

The study used survey design in order to examine the research question. Snowball sampling were used to recruit participants from the general public in Norway, as was the aim for the study. Participant recruitment included sharing a link to family and friends of the research group members in which people got information about the research project and could sign up in order to participate in the research. The project was described as a psychological dream study aiming at investigating different variables that might affect dreaming.

Participants were asked to fill out an online survey each day over a four-week period, starting from March 11th to April 8th 2022. The first day, participants were to fill out a longer survey, due to items measuring demographic variables. From the second day until end of data sampling, participants were asked to fill out a shorter questionnaire (without the demographic variables). Since the research project aimed to investigate multiple variables that could affect dreaming, the questionnaire included more items than necessary for measuring the variables accounting for the research question presented in this thesis. The participants were informed to fill out the questionnaire every day, which was estimated to take between two to ten minutes.

Ethics

The study was submitted for approval from the Norwegian Centre of Research Data (NSD) in January 2022 and approved March 2022 (637636). The participants gave their consent to participate through an electronic form.

Measurements

In general, the items included in the questionnaire asked about several factors that could correlate with dreaming, such as food, sleep, bed-time activities, mood, and everyday life. Two factors needed to be measured to investigate the research question.

Dreaming frequency

Dreaming frequency were measured using the item “Did you dream last night?”, in which the participants either could answer “no”(0), or “yes”(1). The variable was calculated to show total amount of dreams over the four-week period.

Time of last meal before going to bed

The time of last meal before going to bed were measured with the item “When did you eat last before going to bed”. The participants could answer “less than 1 hour” (1), “1 hour” (2), “2 hours” (3), “3 hours” (4), “4 hours” (5), “more than 4 hours” (6). Since the participants were informed to answer the questionnaire each day, and the time of last meal before bed could vary from one day to another, the variable was calculated to show average time of last meal before bedtime over the measured weeks.

Statistical analysis and illustration making

After the data sampling period, the answers participants had provided were collected. The data were plotted into Statistical Package for the Social Sciences (SPSS) by the one of the supervisors and the two assistants on the project. The dataset was then shared with the rest of the research group.

For descriptive analysis, mean, standard deviation and frequency were used on the sampled data. To analyze if there were any correlation between dreaming frequency and average time of last meal before bedtime, SPSS were used to conduct a Spearsman´s Rho correlation. The dependent variable was total amount of dreams, and the independent variable average time of last meal before bedtime. Spearsman´s Rho was chosen because the two variables were not normal distributed. Jeffrey´s Amazing Statistics Program (JASP) was used to conduct a Shapiro Wilk test, and to make scatterplots illustrating the two variables not being normally distributed.

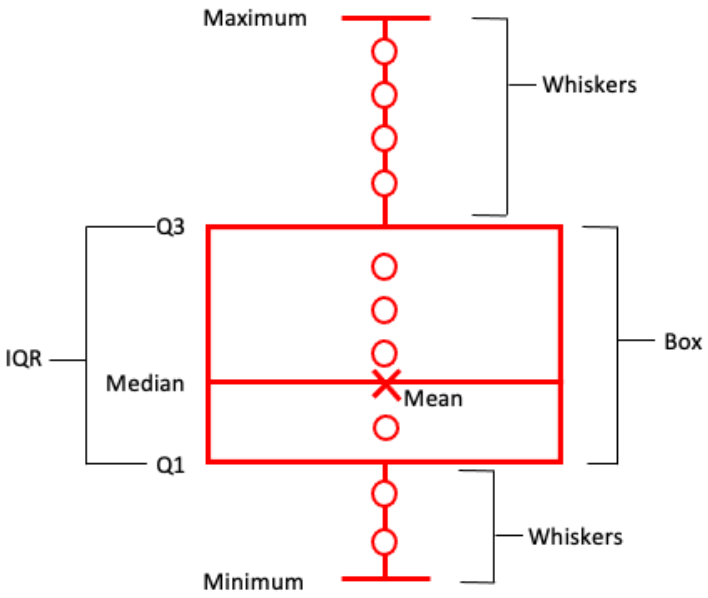
The results being significant or not, it did not indicate whether there were any differences between groups in the data. Therefore, a cluster analyses was used to find out if there were any group tendencies in the data. Due to the limited number of variables an unsupervised two-step clustering analyses was chosen. To indicate whether or not there were any significant differences between the groups a Kruskal-Wallis test were used. A Mann-Whitney post hoc test was used to see where the significant difference was between the

groups. Mann-Whitney test was chosen because two and two groups tested together once at the time was independent and the dependent variable was on ordinal level.

Microsoft Excel was used to make cluster plot and boxplot illustrations of the results from the unsupervised two-step cluster analyses and the post-hoc test, and Microsoft PowerPoint was used to finalize the illustrations. Boxplot was selected to illustrate the results of both variables. Detailed description of boxplot model used have been demonstrated in figure 1.

Figure 1

Explanation of boxplot information



Note. A boxplot includes two parts: a box and whiskers. The middle horizontal line in the box indicated the median value of the data. The cross in the middle of the central horizontal line indicates mean value of the data. The lower line of the box indicates first quartile (Q1) as lower boundary (25%), and the upper line of the box indicates third quartile (Q3) as upper boundary (75%). Interquartile Range (IQR) was demonstrated from Q1 to Q3 and indicated how spread the middle values were. Exclusive method was used in this interquartile range calculation. Whiskers indicates minimum and maximum value. Minimum was calculated as Q3 + 1.5*IQR, and maximum as Q1 – 1.5*IQR.

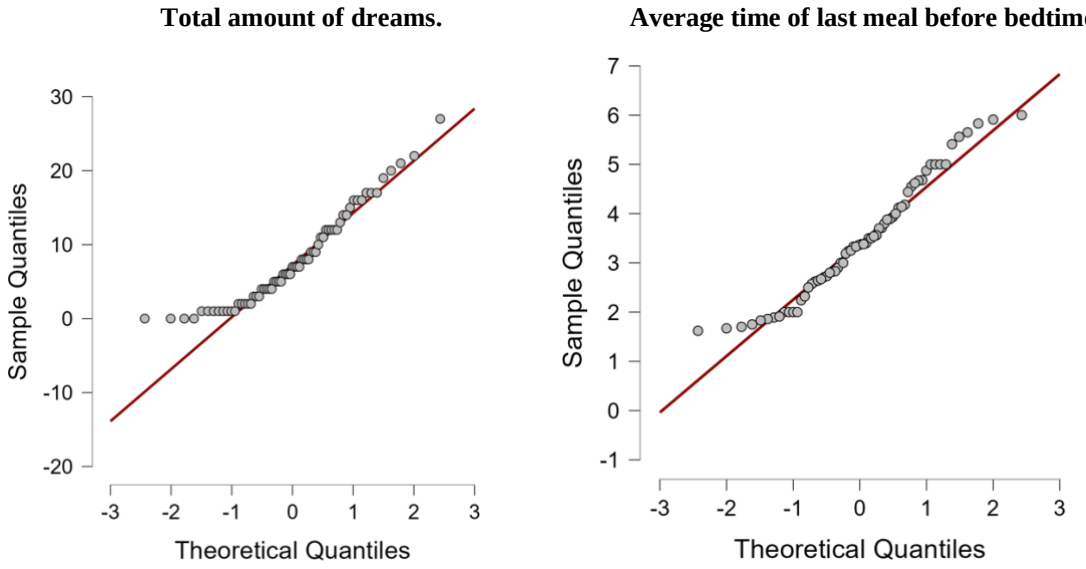
Results

Descriptive

A Shapiro Wilk test showed both total amount of dreams and average time of last meal before bedtime to not be normally distributed. See figure 2.

Figure 2

Shapiro Wilk test results on the two variables measured.



Note. Shapiro Wilk test demonstrated the *total amount of dreams* and *average time of last meal before bedtime* for not being normal distributed.

The result of a Spearsman´s Rho did not indicate any correlation between dreaming frequency and mean time of last meal before bedtime, $r(64) = -.13$, $p = .297$. See table 1.

Table 1

Descriptive statistics and Spearsman´s Rho between two variables (N = 66)

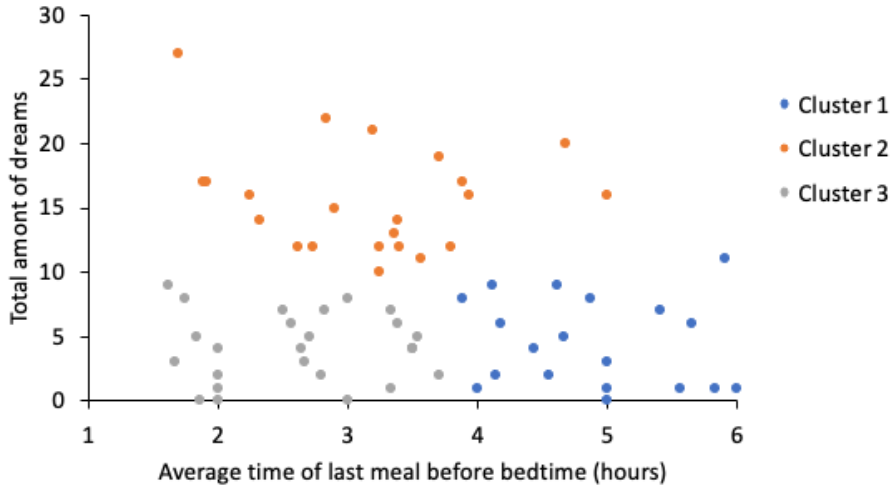
	M	*SD*	1	2
1.total amount of dreams	8.08	6.41	-	
2.Average time of last meal before bedtime	3.46	1.19	-.130	-

Clustering

Despite not discovering any significant correlation, it did not indicate whether there were any clusters or not in the data, or whether there were differences between potential clusters. Therefore, an unsupervised two-step cluster analyses was conducted on the valid respondents (N = 66). The unsupervised two-step cluster analyses successfully identified three clusters (see figure 3), and cluster quality was defined as good with average silhouette = .6, see figure 4.

Figure 3

Unsupervised two-step cluster analyses on the two variables measured



Note. This figure demonstrates three clusters when calculating for total amount of dreams and average time of last meal before bedtime. Cluster 1 (n = 19), Cluster 2 (n = 22), Cluster 3 (n = 25). The three clusters are marked in three different colors. Numbers on x-axis indicating; 1 (Less than one hour), 2 (One hour), 3 (Two hours), 4 (Three hours), 5 (Four hours), 6 (More than four hours). Numbers on y-axis indicating total amount of dreams during the four-week period.

Figure 4

Cluster quality for the unsupervised two-step cluster analyses performed on the two variables.

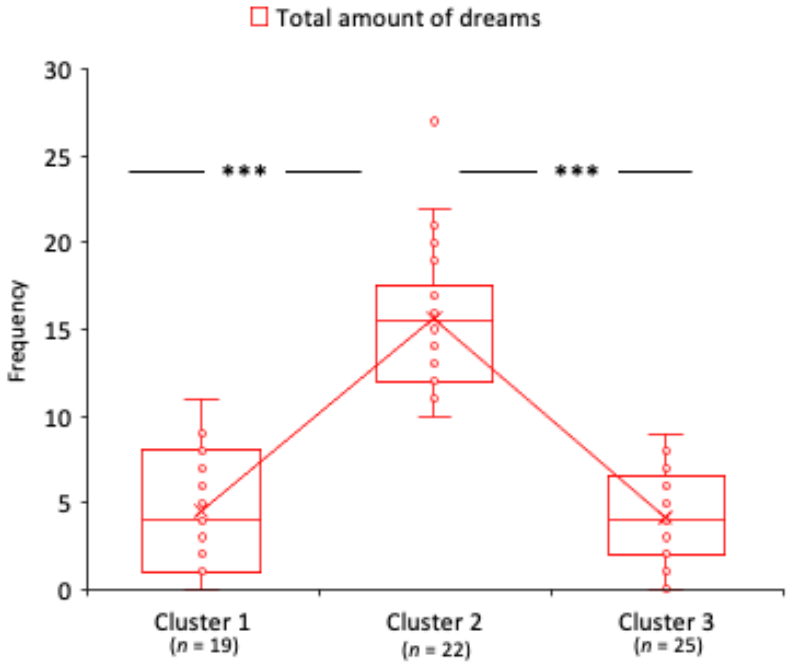
Note. Figure demonstrating cluster quality on the three clusters identified in the cluster analyses. Average silhouette = .6, indicating good cluster quality.

Total amount of dreams

To indicate possible differences in total amount of dreams between clusters a Kruskal-Wallis test was used. The Kruskal-Wallis test showed there were significant differences in total amount of dreams across the cluster, $\chi 2$ (2, N = 66) = 43.27, p < .001. See figure 5.

Figure 5

Kruskal-Wallis test results on total amount of dreams



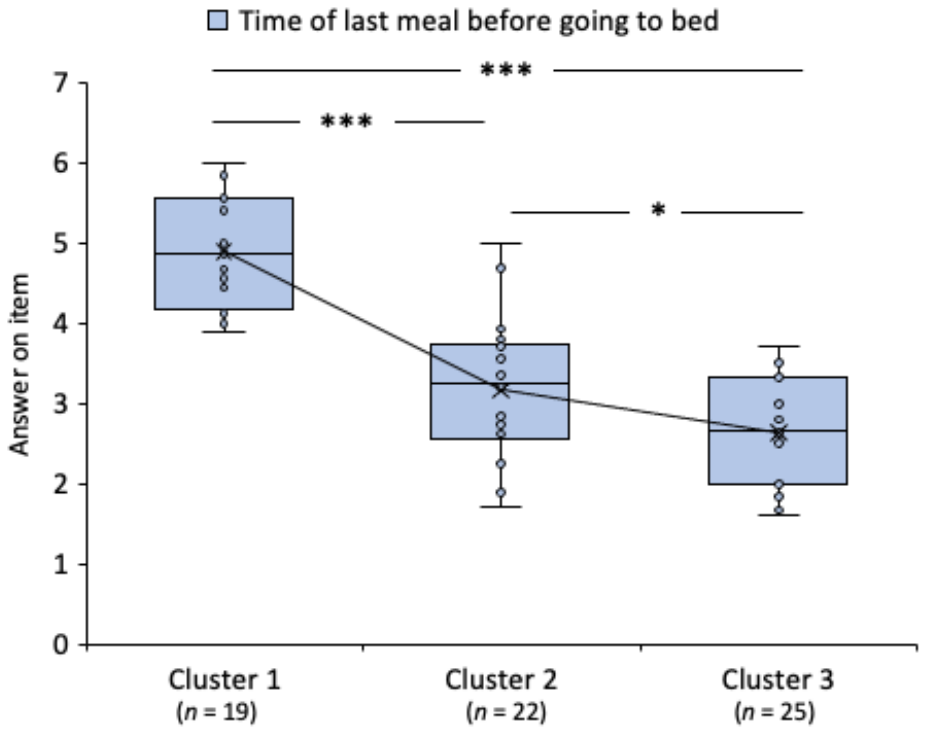
Note. ***p < .001. The figure demonstrate cluster 2 to have significantly higher total amount of dreams than cluster 1 and cluster 3. Cluster 2 had one outlier. Cluster 1 and Cluster 3 did not have any significant difference. Cluster 1 had a mean of 4.47 in dream frequency. Cluster 2 had a mean of 15.68 in dream frequency. Cluster 3 had a mean of 4.12 in dream frequency.

Average time of last meal before bedtime

The Kruskal-Wallis test also showed there were significant differences in average time of last meal before bedtime across the cluster, $\chi 2$ (2, N = 66) = 39.15, p < .001. See figure 6.

Figure 6

Kruskal-Wallis test results on average time of last meal before bedtime.



Note. $^{***}p < .001$, $^{*}p < .05$. The figure demonstrate cluster 1 to have significantly higher average time of last meal before bedtime than cluster 2 and cluster 3 ($p < .001$). Cluster 3 had significantly lower average time of last meal before bedtime than cluster 1 ($p < .001$) and cluster 2 ($p < .05$). Cluster 2 to had significantly lower average than cluster 1 ($p < .001$) and significantly higher average than cluster 3 ($p < .001$). Cluster 1 had a mean of 4.89 in average time of last meal before bedtime, indicating they had eaten approximately four hours before bedtime. Cluster 2 had a mean of 3.16 in average time of last meal before bedtime, indicating they had eaten approximately two hours before bedtime. Cluster 3 had a mean of 2.63 in average time of last meal before bedtime, indicating they had eaten approximately one and a half hours before bedtime.

Differences between every two clusters

A Mann-Whitney post hoc test showed the difference between every two clusters, which detailed analyses is showed in table 2 and 3.

Table 2

Mann-Whitney post hoc test on total amount of dreams (N = 66)

	U	*P*
Cluster 1 and Cluster 2	1.500	<. 001
Cluster 2 and Cluster 3	.000	<.001
Cluster 1 and Cluster 3	0.12	.812

Note. Mann-Whitney test results on total amount of dreams indicated significant difference between cluster 1 and cluster 2 ($p < .001$), and between cluster 2 and cluster 3 ($p < .001$). No significant difference between cluster 1 and cluster 3 ($p = .812$). Cluster 1 ($n = 19$), Cluster 2 ($n = 22$), Cluster 3 ($n = 25$).

Table 3

Mann-Whitney post hoc test on average time of last meal before bedtime (N = 66)

	U	*P*
Cluster 1 and Cluster 2	21.500	<.001
Cluster 2 and Cluster 3	174.500	.032
Cluster 1 and Cluster 3	.000	<.001

Note. Mann-Whitney test on average time of last meal before bedtime indicated significant difference between cluster 1 and cluster 2 ($p < .001$), between cluster 2 and cluster 3 ($p < .05$), and between cluster 1 and cluster 3 ($p < .001$). Cluster 1 ($n = 19$), Cluster 2 ($n = 22$), Cluster 3 ($n = 25$).

Discussion

The aim of the study was to discover meaningful information of time-dependent last meal before bedtime and dreaming frequency. This, in order to provide reasons not to neglect the specific time of last meal before bedtime as an important variable within the dreaming-food-research field. Former studies have to a large degree either neglected or been designed to exclude the time-specific component of the variable. Some studies have only defined last meal before bedtime as being performed between supper and sleep. This could vary a lot in between individuals and be part of the explanation to why dreaming frequency might differ between individuals. Thus, investigating and emphasizing this aspect of the variable has been important for the research conducted in this study. The two hypotheses were sat based on the idea that there should be an association between time-specific meals before bedtime and dreaming frequency.

The results from the study did not indicate any significant correlation between average time of last meal before bedtime and total amount of dreams over the four-week period. Nevertheless, despite not finding any correlation, the results from the cluster analyses did show cluster-tendencies. The clusters were based on the two variables measured, and the results contribute to emphasizing the aim of the study. Thus, the food-variable as being time-specific should not be neglected or excluded in such research studies.

Correlation – *average time of last meal before bedtime* and *total amount of dreams*

The first hypothesis assumed that there was a positive association between average time of food consumption before bedtime and the total amount of dreams in between subjects. 1st hypothesis was not supported. Results from the Spearsman´s Rho correlation did not indicate any correlation between average time of last meal before bedtime and the total amount of dreams. Results not supporting the first hypothesis could be to various reasons. First, on cannot neglect that there actually might not be any correlation between the two variables. However, due to the design of the study there might be other reasons. First, the total amount of participants was quite limited (N = 66). A low sample size could infer a smaller signal-to-noise ratio. This means that the signal (e.g. an effect) is easier to be found, if there is any, in lager sample sizes (Field, 2018, p. 84).

Second, a correlation assumes that the variables are linearly. Therefore, a non-significant correlation may indicate that the association between time of last meal before bedtime and total amount of dreams has a non-linear relation. This could imply that changing

the average time of last meal before bedtime, not necessarily means that it could either increase or decrease the total amount of dreams. Similarly, it could also imply that an increase in dreaming frequency might not lead to people eating on average about two hours before bedtime. Contrary, this might suggest that there exists an optimal average time of last meal before bedtime, that could be associated with a higher total amount of dreams.

Third, it might also be that the inconsistency in time of last meal before bedtime among participants could have affected the association. Not eating at the same time every day before bedtime could influence the rhythm of carbohydrates-, fatty acids-, amino acids-, and vitamins uptake, thus affect how the nervous system goes through, among other processes, energy uptake feeding neural activity and dreaming patterns. Inconsistency in uptake could be part of the explanation for the non-significant results.

Despite not discovering any correlation between average time of last meal before bedtime and the total amount of dreams over the measured period, it did not imply whether or not there were clusters tendencies in the data. By performing a cluster analysis, clusters based on the two variables could be discovered as was the case in this study. The cluster analysis successfully identified cluster tendencies in the data based on participants average time of last meal before bedtime, and their total amount of dreams. This reflects upon the second hypothesis.

Clusters – *average time of last meal before bedtime* and *total amount of dreams*

Second hypothesis assumed that there are differences in average time of last meal before bedtime and total amount of dreams. 2nd hypothesis was supported. The results from the unsupervised two-step cluster analyses displayed three clusters in the data. The cluster quality was good. Cluster 2 had a significant higher total amount of dreams, and significantly different average time of last meal before bedtime, than the cluster 1 and cluster 3. These results indicated that there seems to be an association between eating on average about two hours before bedtime and an increase in total amount of dreams. These results supported the idea from earlier studies (e.g., Yu & Lam, 2017) that eating between supper and sleep is associated with changes in dreaming frequency. However, the results from this study indicated that the earlier studies, who either were designed to exclude or neglected the variable as being time-specific, also failed to include an important aspect of the variables measured. Designing to exclude, or neglecting, this aspect could potentially have affected

their results. Nevertheless, the explanation of why two hours seems to be associated with the highest total amount of hours, is rather difficult to explain precisely.

The mechanism behind the average food consumption two hours before bedtime.

According to the results of the study, eating on average two hours before bedtime seems to associate with a higher total amount of dreams. Why two hours seems to be the ideal time associated with elevated dream frequency is rather unknown. The effect might be caused by different factors. In general food consumption is a way of fueling the body with energy so that it can function in everyday situations. However, different kind of food may affect the body and brain in different ways. Considering the average human diet to contain, among other components, carbohydrates, fatty acids, amino acids, and vitamins, which all have been shown to be associated with sleeping and dreams, it could be rather difficult to exclude several variables in order to present a clear mechanism.

When considering glucose to be important in ATP (energy) production in the body, it could also be part of the explanation. Normal glucose levels during the day are normally around 70-130mg/dL (Kirk & Stegner, 2010). Studies have shown glucose levels to be at around 140mg/dL approximately two hours after eating (Kirk & Stegner, 2010). Thus, considering glucose as an important factor in providing the body with energy, it could be that elevated glucose levels after eating may provide a higher level of energy, increasing the brain activity. Thus, increased dreaming frequency might occur.

In the importance of glucose for energy efficiency in the brain, another important substance should be mentioned. In order to extract the glucose out from the blood stream and into the cells, the peptide hormone insulin is important. Insulin facilitates cellular glucose uptake and promotes cell division and growth. It also regulates lipid, protein and carbohydrate metabolism, in the process of providing energy (Wilcox, 2005). Considering insulin levels to increase after eating, it might be part of the explanation.

Glucose and insulin could be two variables in the mechanism behind why two hours seems to be associated with higher total amount of dreams. However, it is also important to emphasize that combinations of different food, also could affect the association. Insulin levels for instance is shown be higher when eating food rich in carbohydrates and sugars, than eating food rich in fat and protein (Gadgil et al., 2013). Also, combining fat, protein and carbohydrates is shown to give a weaking insulin response than when just eating carbohydrates alone (Gadgil et al., 2013). Therefore, it might be that the combination of not

only the two hours before bedtime, but also the content of the food consumed the two hours before bedtime.

This would also be supported by earlier studies that have shown low-carbohydrate intake to positively correlate with difficulties in sleeping (Tanaka et al., 2013), and higher daytime saturated fat intake to positively correlate with higher nighttime arousal (St-Onge et al., 2016). Not only might glucose and insulin be part of the explanation, but also other substrates, for instance tryptophan and vitamins, could affect the association. Tryptophan, which has been shown to consistently reduce the time it takes to go from being fully awake to sleeping (George et al., 1989), could also be part of the explanation for the two hours. Consuming foods rich in tryptophan, such as turkey, chicken, cheese, nuts, and seeds, could help the body produce serotonin and melatonin (Zhao et al., 2019). Serotonin is responsible for controlling mechanisms related to behavior, and the serotonergic pathways in the brain communicate with other cerebral areas responsible for sleep (Ursin, 2002).
Melatonin seems to also effect sleep. Melatonin is a hormone known for helping with sleep quality (Jafari-Koulaee & Bagheri-Nesami, 2021), and studies have shown food rich in melatonin, such as milk, rice and oats, to be positively associated with improved sleep quality in humans (Pereira, 2020).

Not only trypotphan, but also vitamins could explain parts of the mechanism. Vitamins has also been shown to affect sleep quality and dreaming. Vitamin B-6, as an important vitamin in extracting energy from food, has been shown to affect the cortical arousal during sleep (Ebben, Lequercia, & Spielman, 2002). Thus, eating food, such as tuna, salmon or chickpeas, which all are food high in vitamin B-6, in combination with foods rich in tryptophan, might affect the total amount of dreams. This, not only by itself, but also in combination with the time of consumption. Thus, allowing the body´s system to take advantages of what have been consumed, which might lead to an increase in neural activity making up dreaming patterns.

It is rather likely that the general mechanism behind why two hours seems be associated with higher total amount of dreams, is a combination of all the above-mentioned factors and suggestions. This includes a combination of time-dependent consumption and diets contents, such as the central role of carbohydrates and vitamins. One should also take into considerations different variables not discussed in this thesis.

Advantages

There were several advantages with this study. First and foremost, before conducting the study, a fault of including the variable of food-consumption as being time specific was observed, and therefore investigated. The results from the study indicated that the variable, as being measured time-specific, should not be excluded from such studies. Therefore, one of the biggest advantages that derives from this study is the discovery of a variable that seems to be associated with dreaming frequency, that earlier has been excluded, and which should not be neglected in future investigations.

There are also other great advantages with the current study. The field of studying dreams, especially which factors that can influence them, is relatively new. Thus, most of current conducted research contribute to get a better holistic view of dreams in general. This could eventually lead to a much better understanding, then one has today. Also, studying the relation between food consumption and dreams has not been done in the Norwegian population before. Thus, this study could be considered among the first to investigate the associations between the two variables among the general public in Norway.

Limitations

From the course of this study there have been several limitations. This is due to different reasons. In the original study planned, the research group wanted to include psychological disorders as variables that could affect dreams. Especially when investigating food-dream associations, one would want to include eating disorders. This could also affect the energy consumption the body experience, and further the neural activity making up dreaming patterns.

Not controlling for eating disorders is just one of many third variables (confounding variables) which was not investigated in the current study. Several other variables, such as medication (Baltzan et al., 2020), diet (Zhao et al., 2020), ingredients (Aspy et al., 2018), starvation (MacCullock, 1912), gastrointestinal system diseases (Kramer, 2000), or other diseases with appetite change, could also affect the outcome of the study. To measure and account for every confounding variable would lead to several concerns, as for instance time.

The project was quite time limited, in which some parts of the study had to be solved by downscaling the project. This resulted in items which might not have been ideally operationalized. For the question of interest, this would imply using categories for measuring time of last meal before bedtime. Based on the answers submitted by the participants, some

cases indicated that they had eaten more than four hours before going to bed. Therefore, the study might have had benefited from including more hours, or simply measuring the variable as being continuous. All this, with the participants eating habits in mind.

Participant recruitment might also have affected the results of the study. Members of the research group recruited participants through asking family and friend to participate, known as Snowball sampling. This could lead to that participants who initially did not want to participate, actually participated since the one that asked them had a relation to the participant. There could be several reasons for a person not wanting to participate. One of them could be their knowledge about their own dreams that they do not want to share with anyone else. Thus, their response to the items might have been adjusted to better fit the participants perception what "normal" dreams are like. Another part of this could be that the research project did not give anything back to the participants for their contributions in the project. The only thing, more or less, the participants gained from participating was knowledge about their own dreams and dreaming pattern. Including anything to give back to the participants might also have increased the number of participants. An increased number of participants would also have given better statistical power to the study (Field, 2018, p. 84). The questionnaire that the participants responded to, did also include some items which measured variables not used by any members of the research group. By excluding these variables, the time of answering the questionnaire would decrease, and the number of participants dropping out in the middle of the data sampling period, might have been reduced.

This also reflects upon the fact that this study did not have the same number of participants as earlier studies. Having more participants, similar to earlier studies, could have displayed a correlation between the two variables. However, it could also have changed the results of the present study. This emphasizes the importance of replication, which also account for this study.

Implications and further research

The results from the study showed that accounting for food-consumption before bedtime, as being performed at a specific time, as a variable that can affect the dreaming frequency, might be important and should not be neglected. Earlier studies have either neglected, or been designed to exclude, this aspect of the variables, therefore might also have failed to discover direct associations between the variables measured. Further studies should therefore include time of last meal as being performed during specific hours, in order to

increase the credibility, reliability and validity of their results. The field of studying influencing factors on dreams is relatively new. The results from this study have contributed to a better understanding of the relation between food and dreams. A continuation of this study could further enhance the understanding.

Further studies on the topic should think about several factors when constructing the design. First, based on limitation from the present study, future studies should instruct their participants to eat at the same specific time before going to bed during the data sampling period. This would allow the variable representing time of last meal before bedtime to be measured more precisely, rather than on average. Results from such a study could give better understanding to the specific hour food consumption, and how it affects dreaming frequency. Studies should also include multiple specific time options, such as more than four hours or even half hours. Despite this study measuring the variable as being hour-based, it does not imply that the independent variable is hourly based. In other words, it could be that for example thirty minutes would be better correlated than two hours. A continuation of such studies could also contribute to the discovery of whether the association between time specific food consumption and dream frequency is nonlinear or linear.

Future studies should also include several confounding variables in the food-dream associations. This concerns, among other variables, medication, diet, ingredients, starvation, gastrointestinal system disorders or other diseases with appetite change. Accounting for these confounding variables, and their estimated time to affect bodily functions, future studies should also consider expanding the data sampling period. This would provide more longitudinal studies and increase the credibility of the study. Researchers should also consider providing anything to the participants for their contribution, which might increase their desire to participate. However, what would be provided for the participants should not surpass some participants wish to not participate, as this would be considered malpractice.

To better understand the time specific food consumption-dream frequency association could also imply a better clinical understanding on dreaming disorders. It could assist in improving treatment of patients who suffer from a high frequency of unpleasant dreams. Studies with such an aim, should also include patients into their sampling. When it comes to the overall sampling of food-dream studies, participants should be recruited using another sampling method than snowball sampling. This could be designs including for instance randomized sampling, systematic sampling, or stratified sampling which usually are recommended for such quantitative studies (Langdridge, 2014, p. 47-48).

Complying the overmentioned suggestions for future studies and implications could help to understand the food-dream association at a more holistic level. It could not only help in the research field on its own, but also other fields including clinical work.

Conclusion

In recent years the study of the food-dream association has become more popular. However, studies have either neglected or been designed to exclude the variable of food as being time specific. The current study aimed at discovering meaningful information of time-dependent last meal before bedtime and dreaming frequency, in order to provide reasons not to neglect the specific time of last meal before bedtime as an important variable within the dreaming-food-research field. Results from the study did not display any linear significant correlation between average time of last meal before going to bed and total amount of dreams. However, an unsupervised two-step cluster analyses successfully identified three clusters in the data. Cluster 2 had a significant higher total amount of dreams, and significantly different average time of last meal before bedtime, than cluster 1 and cluster 3. These results indicated that eating on average about two hours before bedtime seems to be associated with an increase in the total amount of dreams. This study was conducted to elevate the knowledge of the food-dream association. It has also suggested other variables that might be important, which was not investigated in this study. Considering the suggestions could increase the credibility and reliability of future research. It could also provide important information which could help understanding the phenomenon of dreaming.

References

American Psychological Association. (2010). *Publication Manual of the American Psychological Association* (6th ed.).

Aspy, D. J., Madden, N. A., & Delfabbro, P. (2018). Effects of vitamin B6 (pyridoxine) and a B complex preparation on dreaming and sleep. *Perceptual and Motor Skills*, *125*(3), 451-462. https://doi.org/10.1177/0031512518770326

Baireuther, R. F. (1997). A descriptive study on the influence of alcohol beverages on manifest dream content. *Dissertation Abstracts International*, 57, 5967. (UMI No. 9705503)

Baltzan, M., Yao, C., Rizzo, D., & Postuma, R. (2020). Dream enactment behavior: review for the clinician. *Journal of Clinical Sleep Medicine*, *16*(11), 1949-1969. https://doi.org/10.5664/jcsm.8734

Chen, W., Qin, K., Su, W., Zhao, J., Zhu, Z., Fang, X., & Wang, W. (2015). Development of a structure-validated Sexual Dream Experience Questionnaire (SDEQ) in Chinese university students. *Comprehensive Psychiatry*, *56*, 245-251. https://doi.org/10.1016/j.comppsych.2014.10.010

Den nasjonale forskningsetiske komité for samfunnsvitenskap og humaniora. (2021). *Forskningsetiske retningslinjer for samfunnsvitenskap og humaniora* (5 ed.) https://www.forskningsetikk.no/globalassets/dokumenter/4-publikasjoner-som-pdf/forskningsetiske-retningslinjer-for-samfunnsvitenskap-og-humaniora.pdf

Ebben, M., Lequercia, A., & Spielman, A. (2002). Effects of pyridoxine on dreaming: a preliminary study. *Perceptual and Motor skills*, 94, 135-140. https://doi.org/10.2466%2Fpms.2002.94.1.135

Emre, M., Aarsland, D., Brown, R., Burn, D. J., Duyckaerts, C., Mizuno, Y., ... & Dubois, B. (2007). Clinical diagnostic criteria for dementia associated with Parkinson's disease. *Movement disorders: official journal of the Movement Disorder Society*, *22*(12), 1689-1707. https://doi.org/10.1002/mds.21507

Field, A. (2018). Discovering statistics using IBM SPSS Statistics (5. ed.). Sage Publications.

Fishbein, D., & Meduski, J. (1987). Nutritional biochemistry and behavioral. https://doi.org/10.1177%2F002221948702000809

Fryan, D. H. (1991). The incidende and significance of perceptual qualities in the reported dreams of patients with anorexia nervosa. *Canadian Journal of Psychiatry,* 36, 517-

520. https://doi.org/10.1177%2F070674379103600710

Gadgil, M. D., Appel, L. J., Yeung, E., Anderson, C. A., Sacks, F. M., & Miller III, E. R. (2013). The effects of carbohydrate, unsaturated fat, and protein intake on measures of insulin sensitivity: results from the OmniHeart trial. *Diabetes Care*, *36*(5), 1132-1137. https://doi.org/10.2337/dc12-0869

George, C. F. P., Millar, T. W., Hanly, P. J., & Kryger, M. H. (1989). The effect of L-tryptophan on daytime sleep latency in normals: correlation with blood levels. *Sleep*, *12*(4), 345-353. https://doi.org/10.1093/sleep/12.4.345

Gillespie, G. (1986). Ordinary dreams, lucid dreams and mystical experiences. *Lucidity Letter*, *5*(1).

Greenwood, C. E., & Winocur, G. (1990). Learning and memory impairment in rats fed a high saturated fat diet. *Behavioral and neural biology*, *53*(1), 74-87. https://doi.org/10.1016/0163-1047(90)90831-P

Halliday, G. (1987). Direct psychological therapies for nightmares: A review. *Clinical psychology review*, *7*(5), 501-523. https://doi.org/10.1016/0272-7358(87)90041-9

Halliday, G. (1991). Nightmares are caused by trauma. In *annual meeting of the Association for the Study of Dreams, Charlottesville, VA*.

Hartmann, E. (1984). The nightmare. The psychology and biology of terrifying dreams.

Jafari-Koulaee, A., & Bagheri-Nesami, M. (2021). The effect of melatonin on sleep quality and insomnia in patients with cancer: A systematic review study. *Sleep Medicine*, *82*, 96-103. https://doi.org/10.1016/j.sleep.2021.03.040

Kalmijn, S., Launer, L. J., Ott, A., Witteman, J. C., Hofman, A., & Breteler, M. M. (1997). Dietary fat intake and the risk of incident dementia in the Rotterdam Study. *Annals of neurology*, *42*(5), 776-782. https://doi.org/10.1002/ana.410420514

Kirk, J. K., & Stegner, J. (2010). Self-monitoring of blood glucose: practical aspects. *Journal of diabetes science and technology*, *4*(2), 435-439. https://doi.org/10.1177%2F193229681000400225

Kleitman, N., Mullin, F. J., Cooperman, N. R., & Titelbaum, S. (1937). *Sleep characteristics* Chicago, IL: Univer. Of Chicago Press.

Kramer, M. (2000). Dreaming and illness. https://psycnet.apa.org/doi/10.1037/10353-003

Kroth, J., Briggs, A., Cummings, M., Rodriguez, G., & Martin, E. (2007). Retrospective

reports of dream characteristics and preferences for organic vs junk foods. *Psychological reports*, *101*(1), 335-338. https://doi.org/10.2466%2Fpr0.101.1.335-338

Langdridge, D. (2017). Psykologisk forskningsmetode: En innføring i kvalitative og kvantitative tilnærminger (4 ed.). Fagbokforlaget.

Lauema, H. (2003). Drug induced dissociate states of a sleep terror patient. *Journal of Trauma and Dissociation*, 4, 137-142. https://doi.org/10.1300/J229v04n03_07

López-Gambero, A. J., Martínez, F., Salazar, K., Cifuentes, M., & Nualart, F. (2019). Brain glucose-sensing mechanism and energy homeostasis. *Molecular neurobiology*, *56*(2), 769-796. https://doi.org/10.1007/s12035-018-1099-4

MacCulloch, J. A. (1912). Fasting (Introductory and non-Christian). *Encyclopedia of religion and ethics*, *5*, 759-765

Merritt, J. M., Stickgold, R., Pace-Schott, E., Williams, J., & Hobson, J. A. (1994). Emotion profiles in the dreams of men and women. *Consciousness and cognition*, *3*(1), 46-60. https://doi.org/10.1006/ccog.1994.1004

Miller, G. (2004). Brain cells may pay the price for a bad night's sleep. https://doi.org/10.1126/science.306.5699.1126a

Nielsen, T., & Powell, R. A. (2015). Dreams of the Rarebit Fiend: food and diet as instigators of bizarre and disturbing dreams. *Frontiers in psychology*, *6*, 47. https://doi.org/10.3389/fpsyg.2015.00047

Noorwali, E. A., Cade, J. E., Burley, V. J., & Hardie, L. J. (2018). The relationship between sleep duration and fruit/vegetable intakes in UK adults: a cross-sectional study from the National Diet and Nutrition Survey. *BMJ open*, *8*(4), e020810. http://dx.doi.org/10.1136/bmjopen-2017-020810

Pereira, N., Naufel, M. F., Ribeiro, E. B., Tufik, S., & Hachul, H. (2020). Influence of dietary sources of melatonin on sleep quality: a review. *Journal of food science*, *85*(1), 5-13. https://doi.org/10.1111/1750-3841.14952

Pourhoseingholi, M. A., Baghestani, A. R., & Vahedi, M. (2012). How to control confounding effects by statistical analysis. *Gastroenterology and hepatology from bed to bench*, *5*(2), 79.

Robert, G., & Zadra, A. (2008). Measuring nightmare and bad dream frequency: impact of retrospective and prospective instruments. *Journal of sleep research*, *17*(2), 132-139. https://doi.org/10.1111/j.1365-2869.2008.00649.x

Schredl, M. (2020). Bad dreams, bedtime anxiety, and trait anxiety in school-aged children. *Somnologie*, *24*(4), 267-273. https://doi.org/10.1007/s11818-020-00268-3

Schredl, M., Geißler, C., & Göritz, A. S. (2019). Factors influencing the frequency of erotic dreams: An online study. *Psychology & Sexuality*, *10*(4), 316-324. https://doi.org/10.1080/19419899.2019.1638297

Secrist, M. E., Dalenberg, C. J., & Gevirtz, R. (2019). Contributing factors predicting nightmares in children: Trauma, anxiety, dissociation, and emotion regulation. *Psychological Trauma: Theory, Research, Practice, and Policy*, *11*(1), 114. https://psycnet.apa.org/doi/10.1037/tra0000387

Solomonova, E., Picard-Deland, C., Rapoport, I. L., Pennestri, M. H., Saad, M., Kendzerska, T., ... & Robillard, R. (2021). Stuck in a lockdown: dreams, bad dreams, nightmares, and their relationship to stress, depression and anxiety during the COVID-19 pandemic. *Plos one*, *16*(11), e0259040. https://doi.org/10.1371/journal.pone.0259040

St-Onge, M. P., Roberts, A., Shechter, A., & Choudhury, A. R. (2016). Fiber and saturated fat are associated with sleep arousals and slow wave sleep. *Journal of Clinical Sleep Medicine*, *12*(1), 19-24. https://doi.org/10.5664/jcsm.5384

Tanaka, E., Yatsuya, H., Uemura, M., Murata, C., Otsuka, R., Toyoshima, H., ... & Aoyama, A. (2013). Associations of protein, fat, and carbohydrate intakes with insomnia symptoms among middle-aged Japanese workers. *Journal of epidemiology*, *23*(2), 132-138. https://doi.org/10.2188/jea.JE20120101

Ursin, R. (2002). Serotonin and sleep. *Sleep medicine reviews*, *6*(1), 55-67. https://doi.org/10.1053/smrv.2001.0174

Wang, C., Xu, J., Wang, M., Shao, X., & Wang, W. (2021). Prevalence and Detailed Experience of Nightmare and Nightmare Disorder in Chinese University Students. *SAGE Open*, *11*(2), 21582440211014193. https://doi.org/10.1177%2F21582440211014193

Wilcox, G. (2005). Insulin and insulin resistance. *Clinical biochemist reviews*, *26*(2), 19.

Yu, C. K. C. (2012). Testing the factorial structure of the Dream Intensity Scale. *Dreaming*, *22*(4), 284. doi:10.1037/a0026475

Yu, C. K. C., & Lam, T. C. (2017). Does eating a fourth meal (siu-yeh) before bedtime affect sleep quality and dream experiences. *International Journal of Dream Research*, *10*(1), 23-29. https://doi.org/10.11588/IJODR.2017.1.31132

Zhao, M., Tuo, H., Wang, S., & Zhao, L. (2020). The effects of dietary nutrition on sleep and sleep disorders. *Mediators of inflammation*, *2020.* *https://doi.org/10.1155/2020/3142874*